UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

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Contribution from the Office of the Secretary.

GRAIN FARMING IN THE CORN BELT
WITH LIVE STOCK AS A SIDE LINE.

By CARL VROOMAN,
Assistant Secretary of Agriculture.

CONTENTS.

This bulletin is written to suggest to the corn-belt farmer of the Middle West—especially the farmer whose soil has been run down by continuous grain farming—some ways of coordinating and "cashing in" the scientific advice offered him in hundreds of bulletins already published. The science of agriculture has been expounded frequently by competent scientific experts, but the practical and business end of farming has had less attention. Now while agriculture primarily is a science, farming primarily is a practical art—a business. A farm is as much a business enterprise

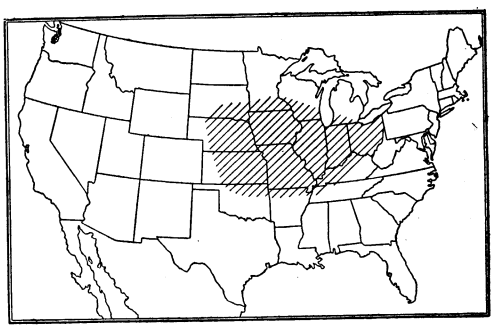

FIG. 1.—Map of the United States, showing by shaded lines the territory to which this bulletin is applicable.

as is a foundry or a cotton mill. Unquestionably it is vastly more than that. It is a *home*, a social and civic center, and the most important unit of civilization. But a recognition of this great truth should not blind us to the fact that the success of the farm home is based upon the success of the farm business. No satisfactory family life, and no satisfactory national life, can be established on other than sound economic foundations. What farmers need most to know is how to make the *science* of agriculture boost the *business* of farming.

We have been in the habit of taking the crop as a unit, printing a bulletin on corn, another on alfalfa, etc. These publications have proved invaluable, and the present type of bulletin is not intended to replace but to supplement them, and to serve as an introduction to a wider and more profitable study of them by the average corn-belt farmer.

This bulletin has been written from the standpoint of the farmer who is farming for a living—the whole farm being taken as a unit and all grain crops suitable for this section being considered in their proper relations to each other and in rotation with legumes. Theories and scientific explanations have been cut to the bone. The suggestions given are modeled upon those which for years the writer has given with good results to tenants, as to how to apply scientific methods with profit.[1]

Briefly, these are the conclusions reached by our most successful corn-belt farmers and agricultural experts:

To make a money-maker of a farm that has become a losing proposition through steady grain farming you must in addition to raising standard grain crops—

(1) Grow legumes—alfalfa, sweet clover, soy beans, cowpeas, red clover, or alsike, according to your soil and climatic conditions.

(2) Raise live stock as a side line—thus saving waste in pasture, fodder, straw, etc., holding down your grain sales and keeping up the productivity of the soil.

(3) Keep accounts of receipts and expenditures—thus substituting figures for guesswork as to whether you are making money or losing it *on each crop*.

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[1]Among those in the Department of Agriculture who have supplied data for use in this bulletin are the following:

Edgar Brown, in charge of seed-testing laboratories; M. A. Carleton, in charge of cereal investigations; J. A. Drake, Office of Farm Management; Raymond Evans, Editor, Office of Farm Management; Prof. O. S. Fisher, Specialist in Scientific and Practical Agriculture; Dr. H. B. Humphrey, pathologist in cereal investigations; Dr. Karl F. Kellerman, Assistant Chief, Bureau of Plant Industry; Chas. V. Piper, in charge of forage crop investigations; Dr. George M. Rommel, Chief, Division of Animal Husbandry; Prof. W. J. Spillman, Chief, Office of Farm Management; Capt. W. S. A. Smith, Expert in Farm Practice; F. M. Webster, in charge of cereal and forest insect investigations, and Prof. Milton Whitney, Chief, Bureau of Soils.

While I have received invaluable aid from these and other authorities in this work, I have written the bulletin in my own way and wish to assume full responsibility for the manner in which each subject is handled.—C. V.

(4) Mix horse sense with scientific agriculture—thus adapting the new methods to changes in market, weather, and other conditions.

(5) Try to secure enough capital to enable you to farm right. Most landlords would make larger profits on their fixed investment in land and buildings if they would invest enough additional capital to provide first-class improvements, including such items as silos, tile, fertilizers, hog-tight fences, etc. Tenants likewise would get larger returns on their capital, brains, and labor if they were able to make larger investments in fertilizers, pure-bred bulls and boars, high-grade heifers and brood sows, and enough "help" to enable them to farm to the best possible advantage.

(6) Stick to whatever policy you adopt long enough to try it out. It often takes time and experience to learn to adapt new methods to local conditions. But nothing is as certain to bring failure as flopping irresolutely from one plan to another.

(7) Confer with your County Agent and make a careful study of the bulletins of the United States Department of Agriculture, and of your State Agricultural College, concerning the particular problems that trouble you.

THE SOIL.

The farmer who robs his soil is sawing off the limb upon which he is sitting. How can productive soils be kept productive and poor soils be made more productive? On the way we solve this question, more than upon any other one thing, hangs the future of farming in America.

WHAT TO DO.

Given a run-down farm in the corn belt, the best and shortest cut to profitable yields generally is to be found through legumes and live stock. To open this short cut, however, we must follow certain fundamental rules in handling the soil.

(1) *Put humus into the soil.*—That is the first move toward building up a run-down farm. Humus is the stuff with which nature fertilizes uncultivated soils—the rotted remains of dead leaves and grass, of weed stalks, fallen logs, plant roots, and the like. Without humus the soil would be merely mineral matter, just rock more or less finely ground and decomposed. Organic matter increases the water-holding capacity of the soil, and as it rots down to form humus, it furnishes organic plant food for bacteria and plants, and by chemical action increases the *available* supply of mineral plant food that comes from the fine rock particles in the soil.

To get humus, plow under all the waste vegetable matter you can obtain—all stable manure, straw, cornstalks, stubble, leaves, weeds and green manure crops, such as clover. Anything vegetable that will rot in the ground makes humus when it has decayed. Legumes should be

used for green manure crops when possible, because they add more nitrogenous plant food to the soil, whereas other green manure crops merely make the plant food on hand more available. Never burn straw or cornstalks unless absolutely necessary—it's like burning money. Spread your straw upon the field next to be plowed, or better still, use it first for feed or bedding or as a mulch for some crop like potatoes and plow it under later as stable manure or with the refuse of the crop.

(2) *Establish a sound and regular rotation of crops.*—It is difficult to make a general rule as to crop rotations, because rotations vary with local conditions, but there are some rules in this regard that hold anywhere. A two-year rotation, such as corn and oats, is entirely inadequate. Every rotation should include at least one legume crop. The rotation should be planned with the aid of your County Agent or your State Agricultural College to fit the individual farm and local conditions. (See "Rotations," p. 12.)

(3) *Select your crops to suit your soil.*—Some farms have grown crops that have depleted the humus and diminished the productivity of the soil until it is no longer possible to grow profitable crops of corn, oats, and timothy. Yet such soil often will produce good crops of some annual legume, such as soy beans or cowpeas. Where nature grows sweet clover you can grow sweet clover, too, and after you have plowed under a crop of that rank growth you have a good start on the road to fertility. Remember, there's a legume crop for almost every soil, and that no rotation is complete without a legume. Try to find the legume best suited to your soil and conditions, and then make it the basis of your rotation.

(4) *Use drain tile freely.*—Artificial drainage is a factor of great importance in soil improvement; often the factor of greatest importance. It enables us to grow potatoes or onions where nature can grow only cattails, because it insures the even distribution of both the water and air that our cultivated crops demand. Where the land lacks natural drainage, everything else depends on how thoroughly the soil is ditched or tiled.

(5) *Suit your plowing to your soil.*—As a rule, the harder the soil is to break, the deeper and the more thoroughly it must be broken up to let air in to do its work. (See "Tillage," p. 7.)

(6) *Manure as regularly as you harvest.*—Stable manure is the best form of fertilizer, because it not only adds available plant food, but also improves the physical texture of the soil. It tends to lighten heavy soil and to make sandy soil hold more water. Stable manure contains easily available plant food, both organic and mineral, and as it decays in the soil hastens the liberation of other plant food. Green manure is an excellent substitute for stable manure, and is essential to good farming where little or no live stock is kept.

Where stable manure is not available, green manure *must* be used to get results. Not merely stubble, but the entire green crop must be plowed under to make a green manure crop a good substitute for stable manure. In the case of a legume manure crop, the seed should be saved, but all the rest of the crop should be returned to the land.

(7) *Correct soil acidity with lime.*—Lime is the one thing most needed by the average run-down soil. It is perhaps safe to say that more poor crops are due to sour soil than to lack of plant food. Certainly most of the failures of clover and other legumes are due to soil acidity. On sour soils lime is needed to neutralize the acid. If your sod fields show patches of red sorrel, moss, poverty grass, and the like, scanty or sour-tasting vegetation, and if your legume crops fail to respond readily to applications of stable manure, try lime.

Crushed limestone is the best form of lime to use in ordinary farming. The limestone particles break up slowly and one application will last for several years. It should be put on at the rate of 2 to 4 tons per acre. Special spreaders are sold for this purpose. However, if one does not care to buy a lime spreader, an ordinary manure spreader may be used, by putting a thin layer of straw or coarse manure on the bottom of the spreader, with the crushed stone on top. If your spreader is set to spread four loads per acre and you wish to apply, say, 3 tons of lime per acre, then use one-fourth of 3 tons, or 1,500 pounds, of the crushed stone per load.

Burned lime may be used to advantage on gardens and on soils abnormally rich in humus, such as peaty loam. A little over a ton per acre will equal 2 tons of raw stone. Burned lime should never be used in ordinary farm practice on normal prairie soils, as it tends to burn out the humus. Crushed limestone does not have this effect.

Experiments with lime and limestone made by the University of Illinois show a gain in yield of $2.64 per acre per year at a cost of 50 cents per acre per year on soil treated with lime in some form (145 tests, covering six years). (Circ. 110, Illinois Experiment Station.)

Burned lime brings bigger yields for a few years, but crushed limestone is best in the long run. The Pennsylvania Experiment Station tried burned lime and limestone side by side on the same soil for 30 years, and during that time the plats treated with the raw stone produced 2.6 tons more of hay, 22 bushels more of wheat, 106.7 bushels more of corn, and 154.7 bushels more of oats per acre than the plats treated with burned lime. In 1908 the Pennsylvania Experiment Station started work comparing the effects of equivalent amounts of air-slaked burned lime and raw ground limestone on a rotation of corn, oats, wheat, and hay (clover and timothy). After six years' test the air-slaked lime gave a total increase over the untreated check plat of

$2.69[1] per acre, against an increase of $7.93 per acre for the plat treated with raw ground limestone. This gives a balance of $5.24 per acre in favor of the raw stone. The increase of $2.69 per acre on the plats treated with air-slaked lime would just about pay the cost of the treatment, while the increase of $7.93 per acre for the raw limestone rock gives a net profit of a little over $5 per acre. (Penna. Experiment Station, Bulletin 131.)

It is most economical to buy limestone in car lots. It is not necessary that the crushed stone be finely ground; what is known as screenings, containing, with the coarser pieces, all the dust made in grinding, will do. The stone commonly used for the top dressing of limestone roads is a little coarse for liming soil, but if the dust is not screened out it will do in a pinch.

The cost of crushed limestone in the corn belt, delivered on your nearest siding, varies with your distance from the nearest quarry. In most cases it runs from $1 to $2.50 per ton. A carload varies in weight from 30 to 50 tons, according to the size of the car.

(8) *Use phosphates when needed.*—Phosphorus, next to lime, is the mineral plant food probably most needed by the average unproductive soil. There are three forms of phosphorus in common use—finely ground rock phosphate (floats), acid phosphate, and steamed bone meal.

Rock phosphate comes from the phosphate beds of the southeastern States, and costs the corn-belt farmer from $6 to $8 per ton, including freight. It should analyze from 12 to 15 per cent phosphorus. Rock phosphate should be ground so fine that at least 90 per cent of it can be washed through a 100-mesh wire sieve.[2] Rock phosphate should be applied at the rate of from one-half to two tons per acre, and should be used in connection with stable manure or green manure crops, as the decaying organic matter is *necessary* to liberate the phosphorus from the rock. Like limestone, rock phosphate should be brought by the carload. The most economical way to handle it is to haul directly from car to field. When the distance from the siding to the field is not over 2 miles, three men with teams and wagons can easily unload and spread a carload of rock phosphate in two days. Two men can haul while the third spreads, the third wagon always being left standing in the field from which to fill the spreader, while the other wagons are loading or on the road. It is usually best to have a regular crushed-rock spreader for this work, but an ordinary manure spreader may be used. (Follow plan for spreading crushed limestone, p. 5.) When it is not convenient to apply the rock phosphate directly to the field, it may be stored in the barn or stable and later

[1] Corn, 50 cents per bushel; oats, 32 cents; wheat, 80 cents; hay, $10 per ton; stover, $2.50 per ton.

[2] A sieve with 100 holes to the running inch, or 10,000 to the square inch.

distributed with stable manure, either by spreading from 100 to 150 pounds on each load of manure when hauling to the field, or by dusting the stable gutters with it and mixing it with the manure as it is made.

Acid phosphate is made by treating raw rock phosphate with sulphuric acid, thus producing a mixture which usually contains from 6 to 7 per cent of phosphorus, and costs $12 to $15 per ton, including freight. This phosphorus is more available than that in the raw rock, and acid phosphate may be used to a certain advantage without the addition of fresh organic matter to the soil treated. Where quick results are desired, or where not enough manure is to be had, acid phosphate may be used with good effect. It is usually applied at the rate of 300 to 400 pounds per acre. Use a regular fertilizer spreader, or a fertilizer attachment on a drill. If a machine is not handy it may be scattered broadcast by hand.

Steamed bone meal is made by grinding and steaming bones from slaughter and packing houses. It ordinarily contains about 12½ per cent of phosphorus in a very available form and costs from $25 to $30 per ton, including freight. Thus the phosphorus in it costs approximately the same as in acid phosphate. Steamed bone meal should be applied at the rate of 200 to 250 pounds per acre and should be handled the same as acid phosphate.

When soil contains an ample supply of organic matter and the object in buying phosphorus is to increase the supply of this element in the soil at the lowest possible cost, this can be done by purchasing finely ground rock phosphate. On the other hand, if the supply of organic matter in the soil is limited or you are anxious to get quick returns from the phosphorus, it is advisable to purchase either acid phosphate or steamed bone meal. As a ton of rock phosphate contains generally about 250 pounds of phosphorus, when sold at the average market price the phosphorus in it will cost the farmer about 3 cents a pound. Acid phosphate generally contains about 125 pounds of phosphorus to the ton and steamed bone meal about 250 pounds to the ton, and when sold at the average price the phosphorus in either of these forms generally costs from 10 to 12 cents a pound.

In spreading phosphorus in any form try to make the application as uniform as possible rather than to put it directly into the hills or rows. Thus it will be everywhere available to the small feeding roots that are distributed throughout the surface soil. (For fuller details on soils, see Farmers' Bulletins 245 and 406; for fertilizers, see Farmers' Bulletin 278.)

TILLAGE.

Tillage is plowing, harrowing, dragging, disking—anything done to stir the soil, either before or after the planting of the crop. As farms become older and fertility declines tillage becomes more and

more important until on "worn-out" farms it becomes the factor of chief importance in the production of crops.

The principles of good tillage are practically the same for all conditions:

(1) Stirring the soil breaks it up. The smaller the particles of soil the greater the area the root hairs or "mouths" of the plant have to "graze" on. Good tillage gives the crop more soil surface on which to feed without increasing your taxes.

(2) When fresh vegetable matter is present, stirring the soil tends to make more plant food available. The organic matter is brought into closer touch with the mineral particles of the soil, and plant food is set free by chemical action as the vegetable matter rots down.

(3) Air is as necessary for the roots of plants as for the leaves. Plants die if there is no air in the soil. Tillage aerates the soil, supplying oxygen, which is used directly by the soil organisms, and nitrogen which is used by legumes by means of the nitrogen-gathering bacteria which live on their roots. Oxygen is also necessary to the decay of vegetable matter in the soil.

(4) Tillage tends to regulate the water supply in the soil. Well-tilled soil absorbs rain more rapidly than does a hard soil, and permits a freer circulation of moisture brought up from below by capillary action, such as occurs in a lamp wick. Like a sponge, it takes water more quickly and stays moist longer than does soil that is packed hard.

(5) Tillage kills weeds.

Briefly summed up, then, we till to make a home for the growing plant, to set free plant food, to aerate the soil, to get and use moisture and to kill weeds.

HINTS ON PLOWING AND CULTIVATION.

Most old farms have been plowed at a uniform or decreasing depth for many years. Thus the top soil lies on a hard floor, or "plowpan," a few inches below the surface. This floor should be broken up. Your deed calls for the subsoil as well as the surface soil, and the subsoil is a mine of fertility and a well of water if properly utilized. An inch or two of new soil should be turned up each year till you have thoroughly broken up the "pan."

It is of far greater importance than is generally realized to plow level fields of loam soil in the fall for spring planting. The frost has a beneficial effect on fall-plowed land. The farmer who fall plows all suitable land will find in the spring that he is in the highly favorable position of starting ahead of the game. Probably no one thing is more important in farming than keeping up with your work rather than being always a few days too late to get the best results.

Hill lands have a tendency to wash if broken in the fall. Some kind of cover crop, such as clover or rye, should be sown on steep

slopes to afford protection during the winter months. In plowing hills the principal object is to plow so water will run off slowly, thus avoiding washing. Always plow around a hill so as to keep your furrow as nearly level as possible. Washing can be minimized still further by terracing. The "Mangum" system of terracing is perhaps the best. (See Bureau of Plant Industry, Circular 94.)

Do not harrow fall-plowed land until spring, when the fall-plowed land for corn should be harrowed or disked and harrowed as soon as possible after the oats are in. This kills weeds, forms a dust mulch and saves moisture that otherwise would be carried off by the spring winds. Great care should be taken, however, to keep off the ground while it is wet.

As soon as the ground is dry enough all land to be spring plowed should be well disked in order to cut up stalks and rubbish left on the ground, as well as to form a mulch for the double purpose of holding moisture in the subsoil and of hastening the drying out of the surface soil after heavy rains. Disking more than half pays for itself by making the ground plow easier and by mixing the vegetable matter with the soil, so that it will not lie at the bottom of the furrow slice and hinder the free circulation of water.

In the spring follow the plow with the harrow immediately. Do not call a day's plowing done until the newly plowed ground has all been harrowed. In very dry seasons it may pay to harrow both at noon and evening. The saving in moisture through harrowing before the ground has had time to dry out is surprisingly great, and one harrowing when the earth is loose and moist will often put it into better tilth than three harrowings after the clods have dried. If the soil is too wet to harrow immediately, don't plow.

Sandy lands need special care. Keep such soils well packed to prevent blowing. Always harrow and roll sandy land immediately after plowing. The subsoil packer, a special type of corrugated roller, seems to produce satisfactory results on such land, as it "firms" the soil and still leaves the surface mellow. When the ground is not in use for other crops, some cover crop, such as rye, vetch, or cowpeas, should be grown.

Where cornstalks are not used for winter feeding they may be plowed under as soon as the corn is husked. This gives time for the stalks to rot in the ground over winter, leaving the ground in excellent condition for seeding either oats, corn, or other crops in the spring. (For fuller details on tillage, see Farmers' Bulletin 414.)

STANDARD CROPS.

Oats.—Prepare the ground for oats as early as possible. Oats do best with an abundance of moisture and cool weather, which cause them to stool out and make a vigorous growth. It is a mistake to

think oats can make a full yield when the seeding is not properly done. Oats pay well for a good seed bed if the work is done early enough. If they are to be seeded on plowed land, the land should be double-disked and harrowed before seeding. In drilling them in, a light harrowing after seeding will put the field in excellent condition unless the ground is very dry, in which case it should be rolled before the final harrowing. If drilled in on cornstalk land without plowing, the field should be double disked before seeding to cut up the cornstalks and prepare a seed bed; then after seeding, double-harrowed and rolled if necessary.

If oats are seeded broadcast the ground should be prepared as for drilling, and then double-disked and harrowed after seeding to cover the seed. As a rule, broadcasting oats will not produce as good crops as when they are drilled.

Oats are probably the least profitable standard crop in the corn belt. As a matter of fact, most farmers in the southern part of this region lose money on every acre of oats they raise, if in figuring the cost of production interest on land values is included. It is generally conceded that oats are grown at a loss in certain sections, but the farmers grow them there nevertheless because they regard them as a necessary part of a successful rotation. While to a certain extent this is true, our best farmers gradually are learning to substitute other crops for a part of the usual oat acreage. The best known substitute crops for oats are wheat, rye, barley, alfalfa, and soy beans or cowpeas. (For fuller details abouts oats, see Farmers' Bulletins 420 and 424.)

Corn.—Do not be in too big a hurry to plant corn. Never plant in a cold seed bed. Thorough preparation of the seed bed is more important than early planting in the case of corn. Don't worry if your neighbors get their corn in before you do. They may be replanting when you are cultivating corn ankle high. Use the disk freely before plowing under cornstalks or clover sod for corn. The ground should be double disked after plowing, lapping the disk half its width. Follow the disk with the spike-toothed harrow, and, if necessary, with a clod crusher. During dry seasons the furrow opener is a very good tool to use on the corn planter. The furrow opener is a double disk that is clamped on the planter runners, opening a shallow furrow ahead of the dropper. Thus the corn is planted below the dusty surface soil without being covered too deep. It has a moist bed to germinate in and is assured deep rooting through the filling in of the furrow as the season advances. Corn planted with the furrow opener can be harrowed after the young corn is up without damage to the young plants, as they are below the level reached by the harrow teeth.

The most effective cultivation for corn is that which is done before the crop is planted. The main object of cultivation is to kill weeds, and the best time to do this is when the weeds are sprouting. Much time and labor in summer cultivation may be saved by a free use of big tools, such as the disk, the corrugated roller, and the harrow, before planting. Such tillage kills weeds; at the same time it puts the soil in good tilth and protects the moisture in the soil from the spring winds.

If the soil is well supplied with humus, little cultivation is needed after the corn is well started, provided it does not become weedy. Weeds must be kept down, and when a heavy rain has formed a crust on the soil the surface should be broken up by shallow cultivation that does not disturb the corn roots any more than is necessary. The small feeding roots of corn are very numerous in the surface soil, where they serve to gather food and absorb moisture that would otherwise evaporate.

Soils very deficient in humus demand more frequent cultivation than soils well supplied with organic matter. Soil lacking humus tends to "puddle" under even light rains. It often is profitable to cultivate corn on such soil with a small harrow or one-horse cultivator after the corn is too big to plow with the ordinary cultivator.

Corn is one of the most profitable crops in the corn belt, provided—

(1) First-class tested seed is planted;

(2) Proper methods of tillage are employed; and

(3) The land on which it is grown is suited to corn.

This last condition is frequently overlooked. But nothing is more certain than that it is a losing game to attempt to raise corn on unsuitable land. (For fuller details about corn, see Farmers' Bulletins Nos. 313 and 614.)

Wheat and rye.—Oat fields or clover sod for winter wheat or rye should be plowed as soon as possible after harvest and a fine, firm seed bed prepared. Plowing the fields soon after the first crop is removed will assist in holding the moisture in the soil and will allow the land to be harrowed and disked a number of times to kill weeds.

Wheat should not be seeded too early, especially on rich land or when it is likely to become infested with the Hessian fly. On very rich land early seeded wheat is apt to grow too rank before freezing weather. If wheat becomes so rank that it "joints," the winter freezing will kill it. Where there is likely to be infection from Hessian fly, the seeding should be delayed till after the last brood of the season is hatched. This is usually from September 15 to 25 in the central part of the corn belt. Care always should be used in the selection of seed wheat, and the farmer is advised to consult his County Agent or to write to his State Experiment Station for advice as to the

variety best adapted to his locality. The seed always should be clean and well graded. (For details about wheat, see Farmers' Bulletins 596 and 616.)

Rye can be seeded early and then used for fall and winter pasture. A very common practice is to pasture rye heavily until about May 1, and then allow it to head and produce a grain crop. (For fuller details about rye, see Farmers' Bulletin 614.)

Timothy seeding.—Timothy is still extensively used as a hay crop in some sections, although it is not as profitable a crop as alfalfa, and takes as much fertility from the soil as does corn.

Timothy is usually seeded with clover in small grain in the spring. It also can be seeded in wheat or rye in the fall and clover seeded in it the following spring. This causes a strong, vigorous growth the first season. Usually the first year after seeding the hay will be mostly clover, but the second year most of the clover will be killed out and the field will be largely timothy. The big advantage in having clover with the timothy for the first year's hay crop is the clover keeps the weeds down while the young timothy is getting a start. Timothy sometimes is seeded in the fall without a small grain crop, but weeds are likely to damage the young meadow during the first year when seeded in this way.

No matter what time in the year you wish to seed timothy, the seed bed should be prepared thoroughly and the grain crop seeded first. Then seed the timothy and harrow lightly, rolling if the soil is dry. The seed should never be covered to a great depth.

ROTATIONS.

As previously stated, a two-year rotation, such as corn and oats, never gives satisfactory results. The best that can be said for such a rotation is that it is a trifle better than no rotation. Yields do not fall to as low a level with oats between corn crops, as with corn following corn year after year; nevertheless they soon become unprofitable. Not until you get clover or some other legume into your scheme of farming do you have a rotation that pays dividends in bigger crops.

Many farmers think they are keeping up to date and farming scientifically if they have 5 or 10 acres in alfalfa and get a stand of clover on a 20 or 30 acre field once in two or three years. This is a serious mistake. *The productivity of a farm is not being kept up on a permanent basis unless annually at least one-fourth of that farm is made to grow legumes, which are either plowed under as stable manure or green manure.* We are often asked what percentage of a farm should be devoted to corn, wheat, alfalfa, etc. Owing to changing marketing and other conditions it is next to impossible to make any satisfactory answer to such a question.

Three safe rules can be given, however: First, do not, unless under exceptional circumstances, grow corn in the same field more than two years in succession; second, keep one-fourth of your land in legumes in order to maintain a proper supply of humus and nitrogen in the soil; third, feed as much of your grain as possible to live stock on the farm.

The corn-oats system becomes an effective rotation if you add a year of clover, thus:

Corn.	Oats.	Clover.

A long series of experiments carried on at the Illinois Experiment Station show clearly the benefits of clover when added to the corn and oats rotation. In 1879 two rotations were started; one was corn and oats, and the other corn, oats, and clover. These have been continued without a change, and taking the years 1901 to 1911, inclusive, the average yield of corn in the rotation of corn and oats was 38.1 bushels per acre, while in the rotation of corn, oats, and clover the average yield of corn for the same period was 57.2 bushels per acre.

In sections where oats do not produce good yields wheat may be substituted for the oats, thus:

Corn.	Wheat.	Clover.

The wheat is seeded in the standing corn by means of a special drill, or the corn may be cut and shocked and the wheat seeded between the rows of corn shocks. An objection to this rotation is when the stalks are left on the ground they sometimes blow down and it is not possible to drill between the rows. In this rotation wheat is usually the cash crop and the corn is fed to beef cattle or hogs, or to both. It is a good scheme to keep both. Then, the cattle make it possible to feed the clover hay on the farm, and the hogs clean up after the cattle and save the grain that otherwise would waste.

One of the best four-year rotations, known as the "Standard Illinois rotation," is the following:

Corn.	Oats with clover seeding.	Clover.	Wheat.

In this rotation, if the clover fails, an annual legume, such as cowpeas or soy beans, may be used to fill in. One of the chief advantages of the "Illinois rotation" is that wheat follows the legume, giving

plenty of time for preparation of the wheat ground. The first growth of clover may be used as hay, or left on the land as fertilizer; the second growth of clover may be cut for hay or for seed. If thrashed for seed the clover hullings should be hauled back and scattered over the field to be plowed under. It is becoming a general practice in some parts of the corn belt to seed clover in wheat, preferably sweet clover, as it makes a rank growth after the wheat is harvested. This crop is plowed under in the fall or in the following spring. In this way it is possible to have two legume crops to plow under in each rotation and yet grow three grain crops in the four years.

If more corn is desired this rotation can be changed to a five-year rotation by adding one year of corn, as follows:

Corn.	Corn.	Oats with clover seeding.	Clover.	Wheat.

If on the other hand the farm is badly run down and must have a large amount of organic matter and nitrogen added to the soil before corn can be raised profitably, the four-year rotation can easily be changed to a five-year rotation by letting the sweet clover seeded in wheat stand over for a crop the following year, as follows:

Corn.	Oats with clover seeding.	Clover.	Wheat with sweet-clover seeding.	Sweet clover.

(For method of handling sweet-clover crop, see "Legumes," p. 17.)

As sweet clover is a very important crop in parts of the corn belt, the following is given as an excellent plan for growing sweet clover to be "hogged down":

Corn.	Corn.	Small grain with sweet-clover seeding.	Sweet clover.

The first year of corn is planted on sweet-clover sod and by hogging off this crop the field is manured for the second-year corn. Rape may be seeded in the first-year corn at the last cultivation, and by letting the hogs have the run of both corn and sweet-clover fields you get a ration of corn, rape, and sweet clover that is almost ideal for fattening hogs at small cost. The corn raised the second year of the rotation may be husked to furnish grain for winter feeding and

the early spring growth of sweet clover cut for hay; the second cutting of sweet clover being thrashed for seed, the refuse being used for fertilizer. If the wheat or oats straw is fed and the resulting manure returned to the land, the unfed grain and the sweet-clover seed are the only part of the crops removed from the farm, and the humus in the soil is increased rapidly.

The following is a good short rotation for building up a run-down farm:

Corn.	Rye with clover and timothy seeding.	Clover and timothy.

The rye is seeded in the standing corn and the clover and timothy is seeded in the rye early the following spring. The rye is hogged off, the hogs being turned in a fortnight after the rye is thoroughly ripe. As the clover matures, part of it is used for hog pasture and part for hay. The clover-timothy sod is then turned under for corn. By such a plan as this, all of the rye straw is left where it is produced, and all the cornstalks are cut up and worked into the soil; likewise all the manure made by the hogs in gathering the rye and corn is left in the fields. This rotation is well adapted to building up a run-down farm economically. (For details in growing the crops and handling the stock in this system, see Farmers' Bulletin 614.)

For a dairy section, where cows run on pasture, as they generally do in the Middle West, the following is a good rotation:

Corn.	Oats or wheat.	Clover and timothy.	Pasture.

This rotation may be extended to five years by pasturing for two years.

If one prefers to keep fewer cows and grow more corn, the above rotation can be changed thus:

Corn.	Corn.	Oats or wheat.	Clover and timothy.	Pasture.

The field for the second year of corn should, if possible, be manured.

In sections where oats are unprofitable and where the soil, naturally or through continual cropping, is poor, such crops as soy beans and cowpeas often are the salvation of the farmers. Soy beans will be found more profitable than oats very generally throughout the

southern part of the corn belt. Here is a good soy-bean or cowpea rotation:

Corn.	Cowpeas or soy beans.	Wheat.	Clover and timothy.

Both cowpeas and soy beans enrich the soil by adding humus and nitrogen to it. They make splendid green manure, and when thrashed for seed the refuse from the thrashing can be used to advantage for bedding and returned to the soil as stable manure, or can be returned directly to the field by spreading with a manure spreader. On heavy land the soy bean is more satisfactory than the cowpea, especially in certain sections of Ohio, Indiana, and Illinois, and northward. Either of these crops may be grown for forage, pasture, or seed. There is at present a strong demand for the seed at profitable prices, or being rich in protein they make an excellent substitute for tankage in hog feeding.

When alfalfa is used in direct rotation it may be combined with corn with very profitable results, since corn often gives from 20 to 30 per cent bigger yields after alfalfa than after clover. Where alfalfa has been on the ground for several years it is possible to grow two or three crops of corn in succession with profit, especially if part of the corn is hogged down.

In planning an alfalfa and corn rotation the farm should be divided into enough fields so one piece can be plowed for corn and a new field seeded to alfalfa each year. Thus you will need at least eight fields of nearly the same size, four of which will be in alfalfa and three in corn, and one in small grain with alfalfa seeded, as follows:

Corn.	Corn.	Corn.	Small grain with alfalfa seeded.
Alfalfa.	Alfalfa.	Alfalfa.	Alfalfa.

Another way to use alfalfa is to grow it side by side with one of the shorter rotations described on the preceding pages. This puts a field out of the regular rotation for five or six years of alfalfa, when the alfalfa should be turned under for corn and another field put in alfalfa. If you have no difficulty getting good stands of alfalfa, it sometimes pays to plow up alfalfa at the end of two or three years so as to make a shorter rotation. (For method of growing alfalfa, see "Alfalfa," p. 17.)

Sandy lands require special rotations. The hardy legumes should be the basis of sandy-land rotations, soy beans and cowpeas being especially useful for this purpose. When grown for several years in succession on sandy soil, soy beans seem to gain in yield. When used thus with rye between crops as a cover crop this legume is a splendid crop for building up a light sandy soil and offers possibilities of immediate profit. If the rye is seeded as soon as the soy beans are cut, it makes a good growth before winter and furnishes much of vegetable matter when plowed under early in May.

Here is a good sandy land rotation:

Soy beans with rye cover crop.	Corn with rye cover crop.

Thus you have a rye crop to plow under each year and a legume crop every second year.

On the better types of sandy soil clover, alfalfa, or sweet clover may be used instead of soy beans or cowpeas. The farmer on sandy soil if he is to succeed must continually plow down a large amount of green manure unless he is able to produce stable manure or buy it at a very low price.

While the rotations outlined above are not by any means all the good rotations in use, they serve to suggest ways in which legumes may be worked into our corn belt systems of farming with profit. The rotation best fitted for each individual farm can best be worked out by the farmer himself *with the advice of the County Agent and the State Agricultural College*, always keeping in mind the fact that some legume crop must be the basis from which to work in planning any rotation worth while.

LEGUMES.

Alfalfa, soy beans, clover, and sweet clover are the legumes best adapted to the corn belt. Vetch and cowpeas do well on certain sandy loams, but are not so generally profitable as the others. Red clover, formerly the stand-by everywhere, now is considered an uncertain crop in parts of the corn belt. Where it is difficult to get a stand of clover every year, farmers must resort to alfalfa, sweet clover, and soy beans. Sweet clover, looked upon as a weed only a few years ago, promises to be the salvation of soils that are too badly run down to produce red clover.

Alfalfa.—Alfalfa is one of the most profitable known crops. It is probably safe to say that the net returns from alfalfa average nearly

twice as much as those from corn. The average yield of alfalfa per acre for the United States is a little over 2½ tons, compared with an average yield of a little over 1⅓ tons of all kinds of hay. In Illinois the average yield of alfalfa (as reported by the Bureau of Crop Estimates) is 2.85 tons, which would bring $34.20 per acre at $12 per ton, against $19.40 per acre for an average yield of corn (38.8 bushels) at 50 cents per bushel. On one field in Illinois, near Aledo, the 1913 crop of alfalfa yielded 6½ tons per acre and brought a gross return of $82.50 per acre. Another alfalfa field near Monticello, Ill., in that same year brought a gross return of $66 per acre, against $30.50 for corn, $21 for wheat, and $11.50 for oats on the same farm. Moreover, in addition to the direct money returns from alfalfa, big returns are obtained indirectly through increased fertility due to the nitrogen and the humus that alfalfa leaves in the soil.

Alfalfa is gaining in favor in the corn belt, and it is safe to assume that part of the area now occupied by some of the less profitable crops will soon be used for alfalfa. This is true especially of timothy, for a long time the standard hay crop, and of oats.

Alfalfa can be grown almost anywhere in the corn belt with good results, if the crop is handled right. If farmers understood alfalfa better the acreage would be much larger. Alfalfa should be planted on a fertile, well-drained soil, with a porous subsoil. The nature of the subsoil is very important, for alfalfa is a deep rooting crop. The roots will go much deeper in an open, gravelly subsoil than in one of stiff clay. Alfalfa can be made to grow fair crops on poor soil, but if the soil is very thin it is always advisable to put on a good coating of stable manure or grow and plow under a crop of soy beans, cowpeas, or sweet clover before seeding to alfalfa. An application of phosphorus will generally improve the yield, and lime is necessary to success if the land is sour.

On any type of soil thorough preparation of the seed bed is essential. The soil should be worked to a fine and mellow tilth on the surface, with a firm bed below to give a good foothold for the roots of the young plants.

Given suitable soil, there are four requirements for getting a stand of alfalfa in the corn belt:

(1) Well-drained land. Alfalfa must have water, but it should dig its own wells.

(2) Sweet land. Sour land won't grow alfalfa successfully. Use limestone if your land is acid.

(3) A well-prepared seed bed. There is no crop more exacting about its seed bed than alfalfa.

((4) Thorough inoculation. (See p. 24.)

If you follow these rules, the weather is about the only thing that can keep you from getting a stand of alfalfa on the right kind of soil.

Alfalfa is usually seeded broadcast and harrowed and rolled in, but a great saving in seed can be effected by using an alfalfa drill which covers all seed at a uniform depth.

For seeding alfalfa broadcast, the seed needed varies from 15 to 20 pounds per acre. When a drill is used this amount can be reduced one-third. Care should be used to secure good seed, and it is advisable to write to the agricultural college of your State for information as to the best seed adapted to your locality.

It is almost impossible to get too thick a stand of alfalfa in the corn belt. When the stand is thick the more vigorous plants choke out both weeds and the less vigorous plants and make a thick growth of fine hay with slender stalks, while a thin stand makes a rank and woody growth of very coarse hay. The yield per acre from a thin stand may equal that from a thick stand, but the quality of the hay will be inferior. Twenty to forty plants to the square foot is satisfactory and on very rich land the stand may be even thicker and still make a good growth. If a very thin but uniform stand is secured, it may sometimes be reinforced to advantage by working the ground to kill weeds and seeding again among the older plants, harrowing and rolling to cover the seed. However, the success of this method depends largely on the weather. If the seeding is done when there is plenty of moisture, the second seeding has a good chance, but if the weather is dry, the young plants often fail to get a foothold. For this reason, it is usually advisable to plow up the field and reseed if the stand is not satisfactory.

Alfalfa makes good pasture for many farm animals, but owing to the difficulty of getting and keeping a stand, it should be grazed sparingly, and not at all during the first year. Close cropping and tramping of the soil by live stock in muddy weather does serious damage. Cattle and sheep tend to bloat when first turned on alfalfa, hence great care should be taken in pasturing these animals. Hogs do well on alfalfa—indeed, alfalfa pasture, supplemented by a small ration of corn, makes pork about as fast and as cheaply as it can be made. You can pasture several hogs to the acre, allowing them to run at will over the alfalfa meadow without interfering seriously with the regular cuttings. Thus, in addition to the hay crop, you get at least seven months of hog pasture.

Alfalfa is an excellent crop to use in clearing the soil of insects that are harmful to corn and other grain crops. The corn root aphis, white grubs, and other insects that are so injurious to corn will not feed on alfalfa, and after a field has been devoted to alfalfa for three or four years it will be practically free of them. Alfalfa is

also of assistance in getting rid of noxious weeds. Because of the frequence with which it is cut even such weeds as wild morning glories and Canada thistles can be cleaned out of heavily infested fields by cropping in alfalfa a few years. (For fuller details about alfalfa, see Farmers' Bulletin 339 or the bulletins on alfalfa issued by your State Agricultural College.)

Clover.—Clover is still a standard crop in the northern part of the corn belt, where the harm done by drought and hot sun is less than farther south. Medium red, mammoth, and alsike are adapted to certain sections of the corn belt. Crimson clover is unsatisfactory in this region. Medium red and alsike are best adapted for hay. In building up soils it is a good practice to leave, for turning under, as much of the clover as possible. If clover does not make a heavy growth, the part of the spring crop not used for hay may be clipped and left on the land and the second crop cut for seed. The clover hullings should then be spread over the field before plowing. Another plan would be to seed as much red clover as can be used for hay and then seed mammoth clover on the part of the field on which the crop is to be left and plowed under as green manure. Mammoth clover may be cut for seed and also used for green manure by rolling the crop a few days before cutting. The heads then stick up and make a short growth before maturing, and can be cut with a buncher attachment to a mower, leaving a long, prostrate stubble on the ground to be turned under. Alsike is adapted to soils too wet for red clover. It is also good as a mixture with timothy or mammoth clover. In most regions clover does not need inoculation as does alfalfa; however, fields that have not been planted to clover for several years should be inoculated to insure good results. Failure to inoculate, acid soil, and lack of humus in the soil have been the causes of most failures to get a stand of clover. (For fuller details about clover, see Farmers' Bulletin 455.)

Sweet Clover.—Sweet clover is a biennial and is a promising legume for building up poor soils. It makes a big growth on poor soils, and with proper inoculation and plenty of limestone you are almost certain to get a stand. It does not suffer from dry weather as does red clover, doesn't demand as rich a soil as does alfalfa, and makes a heavier growth than either. Sweet clover, like red clover, should be sown in the spring with a grain crop. The hulled seed is the best, and should be seeded at the rate of from 8 to 10 pounds per acre. If the hulls are on the seeds, a heavier seeding is necessary, as the unhulled seeds do not germinate readily. Sweet clover will grow almost anywhere, but it needs lime to make the largest yields. Inoculation is usually necessary. As sweet clover has the same nodule-forming bacteria as alfalfa, soil from an alfalfa field will inoculate sweet clover, and sweet-clover soil will inoculate alfalfa. Stock must be taught to eat sweet clover; when

starved to it, animals soon acquire a taste for it if mixed with other hay or seasoned with a sprinkling of salt water. Sweet clover should be cut before it gets woody and *should never be cut close to the ground*, since the new stems spring from the base of the old stalk and not from the crown of the root, as with alfalfa. (For fuller details about sweet clover, see Farmers' Bulletin 485.)

Soy Beans.—Soy beans are a splendid legume crop with which to fill in when clover or other crops fail, or for building up thin, sandy soil. At present they bring the largest money return when sold for seed, but are a profitable crop, either cut for hay, used for pasture, hogged down, or fed as concentrates. This crop is usually planted a little later than corn, on ground prepared as for corn. Whether sowing solid or in rows, use from four to five pecks of seed per acre. Inoculation is necessary when starting soy beans on a new field. A grain drill is the best tool for seeding soy beans. If they are to be cut for hay, and the land is not very weedy, the beans may be seeded solid, with all the drill hose running; but if for seed, or if the land is foul, it is best to seed in rows. This may be done by closing part of the drill hose. To seed rows 21 inches apart (the usual distance) leave one of the outside hose open, stop the second and third, leave the fourth open, and so on across the drill. A marker, such as is used on a corn planter, may be rigged up to insure accurate spacing.

When soy beans are seeded in rows, the plants will usually make a better growth and produce more seed than when sowed solid, as they not only have the advantage of cultivation, but also get more sunlight than do the plants when drilled solid.

Soy beans may be cultivated with a weeder either when seeded solid or in rows, and the cultivation continued till the blooms begin to appear. If the beans are seeded in rows and the land is very foul, additional cultivation may be given by using an adjustable one-horse cultivator.

Cut soy beans for hay while the leaves are still green and with the beans in the "dough." For seed, cut after the leaves are well ripened and beginning to fall and the seed pods well dried and almost ready to open. If allowed to stand too long, however, a large percentage of the beans will shatter out in handling. Cut for hay with an ordinary mower and rake and bunch as soon as the vines have wilted. It takes several days of bright drying weather to cure the hay so that it can be stacked safely or put in the mow. Cut for seed with the binder, if the vines are tall enough, otherwise use a mower, preferably with a buncher attachment. If you have no buncher, use the mower and follow immediately with the rake. Handle the vines as little as possible.

Soy beans are easily thrashed with either a bean huller or a common thrashing machine. If the latter is used, all the concaves should

be removed and the cylinder run at about half-speed. Thus few beans will be cracked, yet if a good current of wind is kept on the riddle the beans will be well cleaned.

Care should be taken to let soy-bean seed dry thoroughly before putting away in tight bins, as they contain a large amount of moisture.

Another way to handle soy beans is to drill them with corn and then hog off both together. This makes approximately a balanced ration, which serves admirably for hog feed. A field planted in this way is almost sure to give a good cash return. A farmer in Champaign County, Ill., hogged off 40 acres of corn and soy beans in 1914 and found that the field gave him a net return of $9.60 per acre more than any other field on his 800-acre farm. (For fuller details on soy beans see Farmers' Bulletin 372.)

FIG. 2.—Haystack that will settle lopsided.

Cowpeas. — Cowpeas are grown extensively in the southern part of the corn belt, and on poor or sandy land in other parts. Cowpeas vine more than do soy beans and are especially useful for hay or as a green-manure crop. They should be planted, cultivated, and harvested like soy beans. (For fuller details about cowpeas see Farmers' Bulletin 318.)

HINTS ON CURING HAY.

A word on curing alfalfa and clover hay.

Cure your hay in the windrow or in the cock, never in the swath. Otherwise you will lose the best part of your crop—the leaves. Use a side-delivery rake if you wish to cure in the windrow. The sun and air can not get into the bunch made by an old-fashioned rake.

In very warm weather, when the air is dry, it is often possible to rake alfalfa or clover hay on the afternoon of the day it is cut.

After a rain, never shake out the windrow with a fork. If you do, you will lose the leaves. Leave the windrows alone till the sun dries them out on top, then flip them over lightly with the rake. If the hay is in the cock, and gets very wet, it may be necessary to open the cocks a little with a pitchfork, but do this very gently.

Extreme care should be taken to avoid putting legume hay in the mow while damp, as it molds readily. When absolutely necessary to put such hay away while a little damp, the formation of mold may be prevented to some extent by sprinkling a little salt on the hay as it is put into the mow.

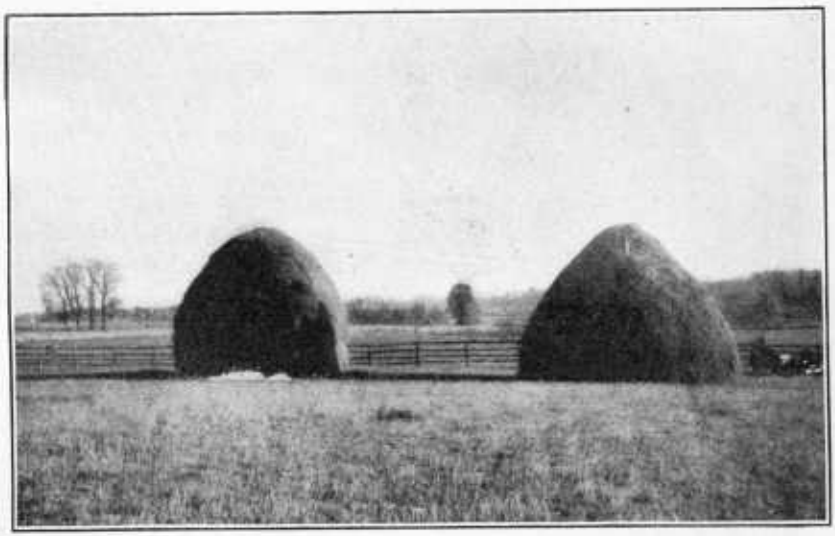

FIG. 3.—Well-built haystacks.

When it is necessary to stack outside, build your stack so that the hay will keep. A common and mistaken practice is to begin drawing in the stack practically from the ground, so as to give it a long slope to the peak. As it is difficult to pack the hay in a stack evenly on all sides without unloading first from one side and then from another, such stacks usually settle lopsided (see fig. 2) and as a result the rain falling on the upper side is likely to penetrate deeply into the stack. If, however, the stack is built up straight from the bulge and then finished with a peak (see fig. 3), the greater portion of the hay will be well protected from rain. However, unless it is absolutely necessary, do not stack either alfalfa or clover without using a cover of some kind. Legume hay does not shed water readily, as does timothy or red top, and in the best of stacks there is always a large percentage of damaged hay, usually representing a loss of more

than enough to pay for a cover for the stack. (For fuller details on hay, see Farmers' Bulletins 362 and 508.)

INOCULATION.

Each legume has a sort of working alliance with a certain kind of microscopic creature which lives on the roots of the legume and pays rent by gathering nitrogen from the air. Sweet clover and alfalfa

FIG. 4.—Nodules on roots of one and two year old alfalfa plants.

have the same bacteria, but in general each legume has a different kind. Inoculation, in this connection, means putting into the soil the right kind of bacteria to help the growth of the desired crop.

There are two ways of inoculating: (1) Field-soil inoculation and (2) pure-culture inoculation.

Field soil inoculation is accomplished by putting inoculated soil from a field on which the crop is well established upon a field to be seeded or upon seed to be sown. Soil from a thrifty alfalfa field or

from a volunteer patch of wild sweet clover may be used for inoculating new alfalfa fields or sweet-clover fields; soil from red-clover fields for new red-clover fields; soil from soy-bean fields for new soy-bean fields; and so on through the list of legumes. Such soil, well sifted, can be applied to the field direct through the fertilizer attachment of a drill or broadcast with a manure spreader. If applied by drill, 200 pounds or more of sifted soil per acre will be enough. If broadcasted, 400 to 600 pounds will be needed. Great care should be taken to keep the sun from shining on the soil used for inoculation, as sunlight kills the bacteria. The soil should be sifted in the shade and should be scattered on a cloudy day or in the evening when the sun is low. After broadcasting, the fields should be harrowed immediately. When the drill is used, harrowing is unnecessary.

In gathering soil for inoculating any legume always take care to examine the plants growing where you propose to get the soil, to make sure that they have plenty of nodules on their roots, thus insuring a good supply of bacteria. (See fig. 4, showing appearance of nodules on alfalfa roots.) The soil can be kept for months in a dark basement, and for early spring seeding it is a good plan to store away in advance enough inoculated soil to inoculate the ground to be seeded.

The inoculation of small seeds with field soil is accomplished by the use of a thin glue solution. Melt 1 pound of common glue in one-half gallon of water and dilute this with warm water till you have 3 or 4 gallons. One-half gallon to 3 quarts of the thin glue will moisten about 2 bushels of seed. Put the alfalfa, clover, or sweet-clover seed to be inoculated on a tight floor or in a wagon box. Sprinkle the seed with the diluted glue solution, using a hand sprinkler, shoveling the seed over and over till all the seed have been moistened. Sprinkle the pulverized inoculated soil on the moist seed, stirring and shoveling it over and over to make sure a little of the dust clings to each seed, using about a gallon of the inoculated soil to the bushel. Allow the seed to dry in a shady place and keep it out of the sunlight till used.

Soy beans or cowpeas can be inoculated in the same way, except that the glue should be somewhat thicker. After melting the pound of glue, dilute to about 2½ gallons. Use the same amount of liquid glue and soil per bushel of seed as for alfalfa.

Pure-culture inoculation is secured through the use of liquids in which the desired bacteria are growing. There are two methods of using these cultures. One method is to take well-sifted soil and mix the liquid culture with it, according to the directions that go with the culture, and to spread this soil on the field to be inoculated, as in field-soil inoculation. The better way is known as "seed inoculation." The seed to be treated are put into a clean bucket or tub and the pure culture is poured on a little at a time, while the seed

is stirred and mixed with the hand till every seed has been given a thin, moist coating of the culture. After moistening, the seed should be spread upon a clean floor or on newspapers and dried. If the inoculation is done in the evening the seed should be dry enough for early morning sowing. Seed thus treated and stored in the dark can be kept for a week or more if the weather prevents immediate seeding.

Pure cultures for legume crops are supplied free, in small quantities for demonstration purposes, by the United States Department of Agriculture. Larger quantities can be bought from commercial dealers.

Pure cultures produce very good results if they are fresh and conditions are favorable. However, most of the legumes seeded in the corn belt are inoculated by the soil method. The pure-culture method costs about $2 per acre, while the soil and glue method costs but a few cents per acre, and entails little more work than the pure-culture method except that required for gathering the inoculated soil. Since there are but few neighborhoods now where there can not be found at least one field of each of the common legumes, the soil method may be used almost anywhere.

TESTING SEED.

It is easy to test seed of all kinds, both for germination and for purity. For the germination test you need only a box that you can make in an hour. For the purity test you need only a 50-cent microscope that will enable you to count the weed seeds in a given number of clover or alfalfa seeds.

One ear of seed corn will produce about 5 bushels—if all the grains grow. If none of the grains grow—and corn is 60 cents a bushel—that dead ear is a dead loss of $3. If you catch but one bad ear in testing, you save a good day's wages—if you find the average number of bad ones *you can save a week's wages in a winter's afternoon.* Still there are farmers who think testing seed is just a foolish scientific frill.

Testing takes only odd hours in winter or early spring, and it may make the difference between a big crop and a crop that does not pay for the labor of cultivation. When you have tested your seed you *know* that your crop will grow if conditions are right—that if you have to replant or reseed it will not be your fault.

(For further details about testing seeds, see Farmers' Bulletins 382 and 428.)

SEED CORN.

The selection of seed corn is most important in insuring a good stand and a good crop of corn. First of all, the corn should be a medium sized, early maturing variety, one that is sure to ripen in

plenty of time to escape the frost. Very few farmers realize that the price of corn and its feeding value are based on the amount of moisture it contains, and that just as large and profitable yields can be secured by growing medium sized ears that will fully ripen as by growing large ears that will not ripen, and therefore contain a large percentage of moisture.

After selecting an early maturing variety great care should be used in selecting the individual ears for seed. These should be selected in the field while the corn is still standing, just as early as the first ears are well dented. The ears should be sound, uniform in size, and well filled and should only be picked from strong, healthy stalks that have ripened as near the same time as possible. The corn should be carefully dried under cover where there is a free circulation of air.

If the seed corn is selected in this way and carefully dried, there will be very little of the corn that will not germinate. However, to be absolutely sure that the seed will grow. it should all be tested by the individual ear method.

If only a few bushels are to be gathered, use a basket or a sack. If a large amount of seed is to be gathered, it will pay to use a "seed corn boat." Nail together three planks, 2 by 12 inches by 12 feet, as you would in making a trough. Cut the ends on a slant, like sled runners, and close the ends with short pieces of board. Thus you have a "boat" that can be drawn between two rows of corn by one horse. In using the boat two men can gather the seed ears from two or three rows on each side of the boat. The use of crates that will slip into the boat will save one handling of the corn. The boat itself will hold about 4 bushels of ears.

In drying seed corn the ears should be spread on slat trays or shelves, or put on specially made drying racks, so that the ears will not touch each other. A serviceable rack is made by driving rows of long wire finishing nails, about 4 inches apart, on four sides of a stick 2 or 3 inches through, and sticking the butts of the ears over the heads of the nails. By numbering the nails on the stick the ears can easily be kept on record during the germination test. The rack should be hung up in any convenient place where the corn will not freeze till it is thoroughly air-dried. Another very good seed-corn rack may be made by taking No. 9 woven wire fencing with 6-inch stays and cutting the wires halfway between the stays. This leaves a core wire with stiff wire prongs sticking out on either side. Stick a seed ear on each of the prongs and bend one end of the core wire into a hook or loop to hang it up by.

Just before planting time, germination tests should be made of each ear. Six kernels are usually tested in making single-ear tests for germination, taking two kernels from opposite sides of the ear near the tip, two from the middle, and two from the butt. Many

forms of germinating boxes are used which are satisfactory. The seed should be kept moist and at about room temperature, not above 90° F. or below 50° F.

A simple tester is shown in figure 5. This is a shallow wooden tray about 1½ inches deep inside. This tray is divided into small squares by a checkerboard lacing of twine across the top. These squares should be about 1½ inches on each side. The tray should be filled level full of loose sand, and in each square is planted the seeds to be tested from an individual ear. The sand should be well moistened when the seeds are first put in the tester, and the tester kept in a warm room. Sprinkle on enough water from day to day to keep the sand moist, and after six or seven days examine the sprouting seeds, and save for planting only those ears from which all the kernels gave strong sprouts.

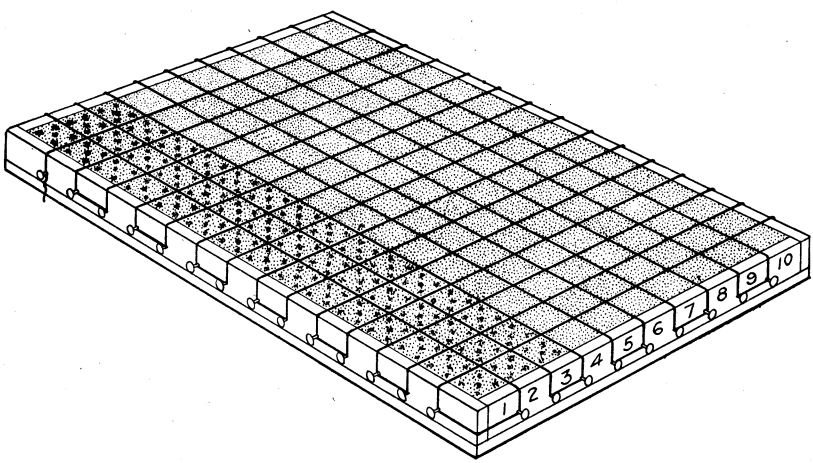

FIG. 5.—Sand tray for testing seed corn.

If seed corn is taken care of in this way, and every ear tested for germination, the result will be the best stand it is possible to obtain under weather and soil conditions at the time of planting. (For fuller details about testing seed corn, see Farmers' Bulletins 253 and 415.)

CLEANING SEED GRAIN.

Small-grain seed should be carefully screened and graded before sowing. This work is ordinarily done with the fanning mill, the lighter kernels and the trash being blown out by a current of air, while the small, shriveled kernels and most of the weed seeds are removed by screens. The proportion of the seed that is removed in cleaning varies largely with the quality of the seed grain. If the grain is plump, heavy, and fairly free from weed seeds, the

removal of about one-tenth of the entire quantity is usually sufficient, particularly with wheat and barley. In the cleaning of fairly good oats and of the poorer qualities of wheat and barley, about one-fourth of the seed should be removed. With very poor oats it is sometimes profitable to remove by cleaning as much as one-half the seed. The screenings are nearly as good for feed as the cleaned grain.

Cleaning and grading removes the small, light or shriveled kernels which will not germinate at all, or if they germinate, will produce weak plants. The removal of these kernels and the sowing of only good, plump seed helps to insure a uniform stand of vigorous plants and increase the yield. Screening also greatly reduces the quantity of weed seed which is sown, thus helping to prevent the spread of weeds and favoring the growth of the grain crop. Except with very poor seed it is usually not profitable to run it through the fanning mill more than once. However, light, trashy seed may need to be fanned twice to obtain seed that is good enough to sow.

All small grain is likely to "heat" when kept in the bin, and as heating may prevent germination, seed grain should be always carefully tested. Dig down a little way into the grain in the bin, take out a handful and put a hundred grains in the seed tester shown in figure 5, or between two sheets of damp blotting paper. Keeping the grains damp and warm for a few days will tell the tale.

Unless 85 or 90 per cent of the seed tested sprout you should increase the amount of seed sown or get better seed.

TREATMENT FOR SMUT.

To prevent stinking smut in wheat, stem smut of rye, and smut in oats and barley, first run the seed grain through a fanning mill to blow out smut balls and fragments of smut masses. Then treat with a solution of formaldehyde (1 pound, or pint, of the commercial "formalin" in 40 gallons of water) or of copper sulphate, also called bluestone (1 pound in 8 gallons of water). This may be done by placing the grain loosely in coarse bags and immersing, or by sprinkling the grain, shoveling it over while so doing, so that every kernel will be wet, and then allowing it to stand in a covered pile for a few hours. After treating, the grain should be spread out and dried as rapidly as possible.

In the method by immersion the period of treatment with formaldehyde for wheat should be not over half an hour; for oats, 2 hours; and for barley, 2 to 3 hours. With copper sulphate, for wheat, oats, and barley, the period should be from 10 to 20 minutes.

Corn smut can not be prevented. Treating the seed is useless and spraying the plants is at least not practicable nor entirely effective. With intensive culture, as with sweet corn, removal and burning of smutted plants may be partly effective. Continuous cropping to

corn contributes to smut losses. (For fuller details and hot-water methods of seed treatment, see Farmers' Bulletin 507.)

Precautions.—No treatment will be effective if all the grain is not thoroughly wetted. Smutty sacks or machinery used with treated seed will contaminate it again. Sacks should be thoroughly soaked in the treating solution.

Wheat from which the smut balls have not been entirely removed should be treated in an open tub so that they may be floated off by stirring and skimming.

Smut will not be entirely prevented in barley by the sprinkling process. By the immersion process other serious barley diseases will also be controlled.

Do not allow the grain to freeze while damp. If the grain is not thoroughly dry when seeded the drill or seeder must be set for a greater rate. The change needed can be determined by measuring the seed before treating and again when ready for seeding.

Copper sulphate (bluestone or blue vitriol) is more likely to injure germination than formaldehyde, particularly if the seed has been scratched or cracked in thrashing. Dipping the seed in milk of lime (1 pound slaked lime to 10 gallons of water) after treatment will sometimes prevent this. If copper sulphate is used the operator should avoid the use of metal vessels.

ALFALFA AND CLOVER SEED.

If you buy a bushel of clover or alfalfa seed for $8 and only 50 per cent of the seed grow, your seed is more expensive than seed at $14 per bushel which gives a test of 98 per cent live seed. If part of the 50 per cent that grow turn out to be weeds, you are worse off still. Buying seed is a business proposition, not an exercise of faith. No farmer who buys his seed "sight unseen," no matter how well he knows his dealer, deserves much sympathy if he fails to get a good stand. It is advisable to write to your State experiment station for information as to the best variety of alfalfa seed to use.

Always buy seed by sample. Tell your dealer that you will buy so many bushels of such and such seed subject to test. Get a handful of seed from a well-mixed bag and ask the dealer to set the bag aside, subject to your order. Buy several sheets of blotting paper and a 50-cent magnifying glass. A hundred sample seeds passed under the little microscope while you count the weed seeds out one by one will give you the exact percentage of impurity when the count is done. The remaining seeds placed between two wet sheets of blotting paper and kept damp and warm for a few days will tell the tale of living seeds. The sum of the seeds that do not sprout and the weed seeds will give you the percentage of bad seeds in the lot tested. If the sum

is 15, you must either look for better seed or sow about 15 per cent more seed to get the stand you want. *Let your dealer know that you test all the seed you buy.*

In alfalfa and clover seed there is always a certain percentage of seeds that, though good, will not germinate readily because of their hard shells. A way of cracking these shells by running the seed through a swiftly revolving machine has been developed at the Iowa Agricultural College. This process materially increases the percentage of germination in the hard-shelled strains of seeds. (For fuller details about treatment of hard-shelled legumes, see Iowa Press Bulletin 36 and Farmers' Bulletin 676.)

GRASS SEED.

The sprouting test for clover will serve for grass seed of all kinds, but the average farmer who hasn't made a careful study of these seeds can't tell much about the purity of a lot of grass seed. It takes an expert to tell one from another by sight. If you have time to wait for an analysis, and your dealer will hold a lot of seed subject to analysis, you can send a sample of seed to your State experiment station or to one of the seed laboratories of the United States Department of Agriculture and buy on the basis of the analysis you get.[1] Otherwise the best you can do is to buy from the most trustworthy dealer you know.

In this connection the study of seeds in country schools is to be recommended. The analysis and testing of seeds by school children could profitably be made a regular feature of school work.

SOME COMMON PESTS.

The chinch bug is black, with white wings. It winters in dead grass, piles of dead leaves and the like. Burning such rubbish during fall or early winter, especially along fence rows and in other places where the plow does not go, will kill a great many of the bugs. In early summer chinch bugs work first in the wheat fields, migrating to the corn fields when the wheat is cut. They may be killed most easily while thus moving from one field to another, since they do not fly readily at this time, and may be checked by a barrier of some kind and killed after they have assembled along the barrier. The best barrier is a line of road oil, No. 7, run along a narrow strip of earth hoed bare between the migrating bugs and the corn fields. Post holes dug at intervals along this line of oil will

[1] The Federal seed-testing laboratories that are most available for corn-belt farmers are:
1. Seed Laboratory, United States Department of Agriculture, Washington, D. C.
2. Seed Laboratory, Purdue University, La Fayette, Ind.
3. Seed Laboratory, Agricultural Experiment Station, Columbia, Mo.

serve as traps to catch the bugs as they trail up and down the barrier. They may easily be killed wholesale as they gather in the post holes. When the weather is very dry a dust mulch made by dragging a log up and down a plowed strip will check the bugs, but a sprinkle of rain will make such a barrier useless. (For fuller details about the chinch bug, see Farmers' Bulletin 657.)

The Hessian fly looks like a little mosquito. The damage is done by the maggot, which as it grows becomes embedded in the wheat stalk. The fly can not be destroyed in the growing wheat, either in fall or spring. One way to fight the fly is by burning stubble, when that can be done without hurting other crops. Another way is to plow under the stubble deeply as soon as the crop is off. Still another way is to sow wheat as late as possible, so that the young plants will not be above ground at the time when the flies are laying their eggs. When the Hessian fly is prevalent all volunteer wheat should be plowed down. Rotation of crops helps to keep the fly in check. (For fuller details about the Hessian fly, see Farmers' Bulletin 640.)

The army worm may be killed by the use of a poisoned-bran bait, made of a pound of Paris green mixed with 20 pounds of wheat bran. Dampen the mixture with water that has been sweetened with sirup—the refuse sirup from sugar mills is best—at the rate of 2 quarts of sirup to 3 gallons of water and add the juice of half a dozen oranges or lemons. The mixture should be well dampened to a dough, but not enough to render it mushy. Sow the bran broadcast where the worms are feeding. The army worms may be checked when "marching" from one field to another by scattering this mixture in front of them. The bran bait will be eaten greedily while damp, but hardly at all when dry. It is therefore important that the bait be scattered in the evening, or better yet at early daylight.

Cutworms may also be killed by the use of the bran bait. Scatter it about the hills of corn.

The corn-root aphis is perhaps the worst insect pest of the corn-belt cornfield. The aphis lives almost entirely upon the roots of the young corn, being carried from place to place by the common field ants, which keep and herd the aphis as a sort of domestic animal for the "honeydew" it secretes. The eggs of the aphis are kept over winter in the nests of the ants. Rotation is the best means of fighting the aphis, as it does not feed on small grain or legumes. However, if an infested field must be planted to corn a second year, the aphis may be checked by deep plowing and disking during very late fall or winter. This breaks up many of the ants' nests, destroying both ants and aphis eggs.

LIVE STOCK AS A "SIDE LINE."

The farmer who sticks to grain farming as his main product must keep more live stock than the average grain farmer keeps now. The only alternative is to grow large quantities of legumes and plow under good clover or soy-bean hay for manure—a thing that few farmers, on a show-down, have the nerve to do as a regular practice. It seems too much like plowing under money.

In order to get some idea of what effect keeping cattle on the farm has on the yields of grain and hay, the Iowa Beef Producers' Association in connection with the Iowa Agricultural College made a close study some years ago of 20 representative farms, 10 grain farms and 10 live-stock farms. The following are the average yields covering a five-year period.[1]

	Grain farms.	Live-stock farms.
Hay, per acre, tons	1⅕	2⅕
Corn, per acre, bushels	38	52
Oats, per acre, do	32	39

Such figures make a striking illustration of the well-established fact that where live stock is kept and the manure produced is returned to the land, the crops covering a series of years show a decided increase. There is no use trying to dodge the issue; even grain farmers should work more live stock into their scheme of farming.

Here we run into a snag. We can't afford to grow 7 and 8 cent cattle and 6 and 7 cent hogs and feed them entirely on 75-cent corn and other high-priced feeds. What are we going to do about it? Following are a few suggestions as to how the corn-belt grain farmer may get around this problem by growing and feeding enough live stock as a side line to utilize his waste.

Much of the growth of live stock should be made on roughage and cheap pasture. There is an immense amount of feeding material on corn-belt farms which can be sold off the farm at a profit only when fed to live stock. It is largely on this material that the profitable corn-belt live-stock production of the future must be based. Cornstalks, when possible, should be fed as silage or as fodder, and straw must be saved and fed, instead of being allowed to rot in the stack. However, to be of any great benefit as feed, both cornstalks and straw should be fed in connection with some concentrate. In addition to permanent pastures, valuable pasturage can be secured from clover, fall-sown rye, rape, or soy beans sown in the corn or on stubble land. The full corn ration must be held back until the animals are ready to be finished off. By utilizing forage crops and

[1] Proceedings of the Iowa Beef Producers' Association.

pastures in this way in the warmer months and feeding silage and straw in winter, a smaller amount of grain will be needed, and what is fed will be far more efficient in the ration—the animals will make much larger gains than when fed on grain without the succulent ration.

The practice of English and Scotch feeders gives us a valuable lesson in this regard. Their cattle are fattened largely on roughage and roots. In Scotland as much as 15 pounds of straw and 100 pounds of roots are fed daily to steers. In such a ration not more than 7 or 8 pounds of grain will be fed, and of this not more than 3 pounds daily is corn. As much or more cottonseed meal and linseed meal is fed. Usually Scotch farmers depend more on the latter feeds to furnish the concentrates in the ration than on corn meal. They figure that when the manure is carefully saved at least one-third of the value of oil cake is returned to the land in plant food.

By feeding "cake" (linseed, cotton seed, and similar meals), the European farmer counterbalances the loss of plant food resulting from the sale of farm products. The corn-belt farmer should in the future make a larger use of these feeds, or better still grow his own concentrates in the form of alfalfa or soy beans. European farmers would not think of keeping their live stock without concentrates and they get a large part of what they use from the United States. The United States exported in 1911 over 400,000 tons of cottonseed meal, in 1912 over 600,000 tons, and in 1913 over 550,000 tons. The manure made from this feed is worth fully half the original value of the feed itself. In fact, the fertilizing value of manure produced from oil meals is about four times that of manure made from corn.

The problem of keeping live stock with profit is largely a matter of making use of stuff that is wasted on the average farm. Wheat straw, for instance, usually rots in the stack or is used for bedding, yet it may very profitably be used as part of a regular ration. Cattle fed on silage seem to crave dry matter and will eat daily 3 or 4 pounds of wheat straw per head. Idle horses fed 1½ pounds of oil meal and 8 pounds of corn per head each day will readily eat straw for roughness. There are no reliable statistics on the food value of straw, but here is one instance to the point:

On a farm near Sioux City, Iowa, 365 calves were each fed 18 pounds of silage, 1½ pounds of cottonseed meal, 10 pounds of shelled corn, and 4 pounds of wheat straw daily, and showed a daily average gain of 1⅝ pounds per head.[1]

In wintering stock cattle large amounts of coarse roughage can be utilized to advantage if it is supplemented with some cottonseed meal or linseed-oil meal. Mature cattle can be wintered very eco-

[1] The department kept a complete record of this feeding operation, covering a year, and more detailed information may be secured by those interested.

nomically by giving them all of the straw and corn stover they will eat and about 2 pounds per head per day of one of these meals. If mature cows are given 5 or 6 pounds of clover or alfalfa hay in addition to corn stover or straw, they can be wintered cheaply and will usually pass through the winter in good condition; however, this ration can be improved by adding a pound of cottonseed or linseed meal. Mature cows have also been wintered economically on a daily ration of 25 pounds of corn silage, 1 pound of cottonseed meal or oil meal, and a few pounds of straw or stover. There is no other concentrate available for cattle feeding that surpasses these high-protein meals for supplementing farm-grown roughage.

It is usually assumed that for mature beef cattle 1 pound of cottonseed meal or linseed meal is equal in feeding value to 2 pounds of corn.

The hardest month on live stock in the corn belt is April. On many a farm, cattle that have been wintered fairly well are allowed to go through April on wind and water with the additional privilege of running to a straw pile. The use of this straw earlier in the winter as *part* of a balanced ration would make the farmers' limited supply of silage and concentrates go farther and the herd could frequently be carried through to May grass in good condition. It must be remembered that all the winter loss in weight must be made up before the summer gain can begin, and that if half the summer is wasted in making up that loss, profits will be largely reduced.

Weeds and weed seeds, usually counted worse than nothing, may be put on the right side of the ledger by means of a few sheep. A small flock of sheep will thrive on the weediest pasture and it has been shown that sheep make almost as good gains when fed on poor wheat or weed seeds [1] as when fed on corn. See the following table from Minnesota Station Report for 1893:

Cull wheat and weed seeds compared with cracked corn for fattening lambs.

Average ration.	Average daily gain.	Feed for 100 pounds grain.	
		Grain.	Hay.
Lot I:	*Pounds.*	*Pounds.*	*Pounds.*
Cracked corn, 1.3 pounds			
Timothy hay, 1 pound	0.25	523	402
Lot II:			
Small wheat, 1.8 pounds			
Timothy hay, 0.9 pound	.24	745	367
Lot III:			
Pigeon-grass seed, 2.4 pounds			
Timothy hay, 0.5 pound	.27	874	189
Lot IV:			
Wild buckwheat, 2.3 pounds			
Timothy hay, 0.7 pound	.28	816	249

[1] There is always the possibility of scattering weed seed in the manure from these lambs.

Thus you see that small wheat, pigeon-grass seed, and wild buckwheat, materials that sometimes can be bought from elevators at low prices, produce good gains when fed to sheep in somewhat larger quantities than are required to get the same results with corn. When the price of weed seed is low the difference in price will make the low-grade stuff more profitable sheep feed than corn.

It takes good fencing to make the best of the waste on a farm. It costs about $300 to make the fences on a 160-acre farm "hog and sheep tight," but the saving in waste material and waste labor will soon pay big dividends on such an investment. Figuring on an interest basis, even at as high a rate as 8 per cent, the interest would be only $24 per year, and anything gained through good fencing over depreciation and interest on $300 would be clear profit. With good management fencing can be made to pay for itself in a little time.

Every farmer who keeps any cattle should keep at least a few hogs to clean up after the cattle. A small herd of hogs will thrive thus on what would otherwise be sheer waste—the bits of undigested corn, etc., in the manure. Such a bunch of hogs frequently nets a profit that is almost clear "velvet," and that goes far toward justifying any expense put into hog-tight fences.

Another way to get dividends on good fences is to hog down your crops. By sowing 3 pounds per acre of dwarf Essex rape in your corn before the last cultivation an enormous amount of extra feed can be produced with little labor. The rape can be sowed quickly by riding a horse down every third row and sowing broadcast. Once such a crop of feed has been grown the hogs do the rest. On a farm in western Iowa 250 hogs, after having been fed a little new corn to get them accustomed to it, were turned on 160 acres to graze over the alfalfa meadow, rape, and pumpkin, and to hog down 40 acres of corn. They cleaned up all the scraps of corn and fodder that the men left on the ground when the silo was filled, harvested the rape and pumpkins, cropped the alfalfa close, husked the 40 acres of corn, and more than doubled in weight. There was absolutely no waste and no labor bill. That was producing pork economically.

On a farm in northwestern Iowa $50 worth of Essex rape seed was sown after the last cultivation in 60 acres of corn and on 40 acres of oat stubble. After the corn had been husked 160 head of yearling steers were kept for 70 days on the cornstalks and rape, with daily feeds of straw, corn, and cottonseed meal. They were turned into the 100 acres each morning, driven out at 5 p. m., and fed per head 8 pounds of corn, 2 pounds of cottonseed meal, and between 3 and 4 pounds of oat straw. After taking out the cost of the corn and meal there was a profit of $600 from the waste in the 100 acres, and in addition a large amount of feed was furnished for the hogs following the cattle, the entire farm being fenced hog tight.

The common custom of turning cattle in to clean up cornstalks is unprofitable, unless other feeds are added. If you feed a little alfalfa hay and two pounds of flax or cottonseed meal per head daily with your cornstalks, you make those cornstalks worth money to you. If you are afraid or unable to spend a little money for feed to balance the ration, your cornstalks merely go to keep your cattle alive, instead of to make beef. (For fuller details about cattle feeding, see Farmers' Bulletin 588.)

The silo is another money saver. It saves practically all of the 40 per cent of the corn crop that is wasted when you simply husk the corn and leave the stalks. Silos, however, cost money, and the machinery for handling silage is expensive. It is well for the average farmer before he builds a silo to plan carefully and make sure as to what size silo he needs. In order to keep the silage fresh all the time while feeding, a thin layer of about 2 inches should be fed off the entire top each day, and if the silo is so large that this can not be done, some of the silage will mold and become worthless. A silo 12 feet in diameter is a very convenient size to use when the farmer plans to keep from 12 to 18 cows. He should also count the cost well and be sure that the profits promise to justify the investment. Silage is a feed of the greatest value, especially for dairymen, but it does not follow that every farmer needs a silo. (See Farmers' Bulletin 578 for fuller information about silage.)

The time of marketing may have a good deal to do with securing a profit on cattle-feeding operations. As a rule the market is highest for well-finished fat cattle during the summer months, and the feeding operations should be arranged to finish the cattle for market some time during this period. Most feeders buy their cattle in the fall, feed a few months, and then sell during the winter, often when the price is below the cost of production, usually getting little or nothing for the feed consumed. As a general rule the feeder should hold his cattle when everyone else is selling, and sell when there is a strong demand and prices are good.

The sex of the horses you keep may have a good deal to do with the amount of your total returns from live stock. If you keep mares rather than geldings and breed them to foal each year, the colts you raise become a valuable by-product of your farming operations. If the barn has warm box stalls the mare may well be bred to drop her colt late in the fall after the heavy work is over, or early in the spring before the heavy work begins. Ordinarily, however, it is best to breed so that the foal will be dropped in May or early June when the mare and colt can run on grass, but still early enough so that the colt will be weaned before cold weather begins in the fall. Fall colts are a paying proposition if properly handled, but unless the

farmer can provide good warm quarters, and is willing to give special attention to the care and feeding of the young colt and its mother, his best plan is to have his colts foaled in the spring. Any well-bred colt is worth more than enough at weaning time to pay the cost of keeping the mare through the entire year. (For fuller details about colts, see Farmers' Bulletins 619 and 667.)

A great saving in the labor involved in handling live stock can be made by feeding once a day. Many of the best cattle feeders in the West now follow this plan. If the cattle are fed the daily allowance of hay in the morning and the daily allowance of corn an hour afterwards, one man can easily take care of 250 cattle. By feeding the hay first you get around the danger of the greedy steers getting too much corn. It has been demonstrated that there is little or no difference in results between feeding once a day and feeding the same feed in two portions, but there is a marked difference in the cost of the labor involved.

When cattle or hogs are on full feed, one of the best ways of fattening is by the use of the self-feeder. By this system all the feeds are kept before the stock all the time and it is possible for the animals to get more nearly a naturally balanced ration. The self-feeder is so made that there is no loss of feed, and the time required for filling it and keeping it clean is much less than that consumed in hand feeding. At the Iowa Experiment Station it has been demonstrated that hogs will gain faster, and at less expense, by the use of the self-feeder than when hand fed.

SAVING MANURE.

The success of the system above outlined hangs on one very important condition—the manure must be saved.[1] If you break even on your beeves you are ahead of the game provided you save your manure, especially if you have kept hogs following the cattle. To the corn-belt farmer who keeps live stock as a side line, for the purpose of building up his soil, the manure represents a large percentage of the profit, often the entire profit. If you allow these profits to be wasted, then the safest thing to do is to leave live stock alone.

"Saving manure" in this sense doesn't mean saving merely the one-fourth or one-third of the manure produced that is saved on the average farm. It means saving 70 per cent or more, liquid as well as solid.

[1] How important a factor in farm life this is may be seen from the fact that the value of farm manure in the United States, if all the manure was properly saved, would be greater than that of the combined mineral and timber output of all our mines and forests. If properly saved, the value of the manure produced annually would be $2,225,700,000. At least half of this is lost through carelessness, making an annual loss to the American farmers of $1,112,850,000. (See Farmers' Bulletin 192, p. 5.)

If the manure can be hauled to the fields as fast as it is made, that is the cheapest and most effective way to handle it; if not, it may be stored in concrete pits. Cattle and hogs not fed on pasture should have paved feed lots and the lots should be kept heavily bedded with straw. The saving in the manure and in the increased gains of the animals will soon pay for the concrete work.

If a farmer can not afford a concrete manure pit or a paved feed lot, he can save a large percentage of his manure, both liquid and solid, by feeding under a cheap open shed and bedding heavily. If the feed racks are made so that they can be raised from time to time, it is possible to feed under such a shed till from four to six feet of solidly packed manure has collected. Experience has shown that there is very little heating in manure kept in this way, and that little of the manure is lost by leaching, since the shed keeps the rain off. The practice of allowing the manure to accumulate under the feet of the cattle in such a shed is very common in France.

On days when the ground is dry or frozen it is generally advisable to feed the cattle their roughage in the fields. Thus the manure produced during the day will be left on the ground, to be plowed under in the spring.

When it is realized that a 1,200-pound steer produces 70 pounds of manure per day, liquid and solid, and that perhaps two-thirds of that is lost if the animal is kept in an open feed yard, it is easy to see the advantage of feeding cattle under a shed or in the fields when possible, since it means a saving of about 50 pounds of manure per animal per day—7 tons a year.

When once fitted into the farm plan, live stock should be kept there. Look around you and you will notice that usually the really substantial farmers in your neighborhood are those who have made live stock an integral part of their business and who have stuck to it.

Finally, your live stock should be well bred. The females need not be pure bred, but the bulls and boars should be pure bred in every case. In buying a registered animal two things must be observed particularly: First, the animal must be a good individual. No pedigree certificate can make a poor bull a good one, and the breeding value of the animal comes from the "blood in his veins," not from the typography of his pedigree certificate. Second, he must be a sure breeder.

Any one of a number of breeds will give good results. The best general rule to follow in this respect for the corn-belt farmer is to select the breed which is most popular in the community in which he lives and stick to that unless there is some very good reason for changing to another breed.

SIDE ISSUES.

Utilizing waste time.—The problem of waste time is a serious one on most farms. Rainy weather means losing the farmer's time and that of his hired men, while during the winter and other slack seasons this loss is even heavier. Every farmer should have a list prepared in advance of profitable ways to employ waste time.

Preparedness is as important for the farmer as it is for the soldier. The farmer who wins is the farmer who keeps up with or ahead of the game, who utilizes rainy days and slack seasons to get his affairs in such shape as to enable him to meet the demands of his busy seasons without strain or confusion.

For example, when it is too showery or too muddy to work to advantage in the fields, weeds can be mowed with a mower or scythe; fences can be repaired or built; tools can be overhauled, repaired, or sharpened; buildings can be repaired, hedges can be trimmed or pulled out; bushes can be grubbed from meadows and pastures or along fence rows. The farm garden often can be worked when the weather will not permit field work, and stock farmers frequently can haul hay and straw from the field between showers.

Even the winter season can be made highly profitable if intelligently employed. Stock farmers have a supply of regular work during that season, but they and all other farmers should recognize the possibilities of the winter months as a season of preparation for the rush of work in the spring.

Manure should be hauled out in the winter whenever the weather permits. Farm machinery should be greased or oiled when put away and then carefully gone over during the winter months and thoroughly repaired. Edged tools should be sharpened, harness repaired and greased, extra whipple trees made, and buildings repaired. Fence posts can be cut, and firewood for the year laid in and chopped ready for use. During the winter months needed wells or cisterns should be dug, seed corn should be tested, and small grains should be cleaned and tested.

Moreover, every farmer should lay out for himself, or get the County Agent or the State Agricultural College to lay out for him a course of reading from agricultural bulletins for the winter months.

Every farmer should try to acquire each winter a thorough knowledge of some new crop, or of some new scientific agricultural method. One winter alfalfa could be taken up, the next soy beans, the next pigs, etc. In addition to this, when possible, the farmer should attend, or send his boys to the short course at the State Agricultural College.

Moreover, every farmer would do well during some slack season to visit his nearest terminal market for grain and live stock, in order to study conditions and talk with the officials of the live-stock and grain exchanges, with commission merchants, bankers, and State and Fed-

eral officials. In no other way can he acquire a detailed, first-hand knowledge of market conditions.

In these and in various other ways during the winter months a farmer can prepare himself for successful and profitable farm operations during the rest of the year. The farmer who wastes his leisure time, instead of utilizing it to the utmost advantage, can never hope to catch up by hard work during the busy seasons, for every successful farmer works as hard as he can during those seasons anyhow.

Size of farm.—There is a widespread opinion to the effect that the average American farm is too large. The examples of small, intensively cultivated European farms are cited as arguments in favor of cutting down the acreage of the average American farm. Exhaustive studies of farm operations by the Office of Farm Management have demonstrated, however, that in the corn belt farms under 200 acres are less profitable than those of from 200 to 240 acres.

This is true for several reasons. A farm of 160 acres devoted to standard crops in one of the usual corn-belt rotations is too large for one man and not large enough for two, and it is much more difficult to get good, temporary hired men than it is to get good, permanent hired men. Moreover, a farm under 200 acres does not get the maximum service out of a set of farm implements or out of its necessary quota of work horses. Furthermore, as most farmers have discovered, it is not possible to work out as satisfactorily a rotation of standard crops on 160 acres as it is on 200 or 240 acres.

For these and other reasons it will prove to the advantage of both landlord and tenant in the corn belt, wherever possible, to have the land divided into farms of from 200 to 240 acres.

Keep accounts.—No farm can be be run on a business basis unless the farmer keeps track of receipts and expenditures and balances his accounts at least once a year. It doesn't require complicated bookkeeping to do this. A simple system of accounts that any schoolboy can keep will serve the purpose very well. The problem is to find out just where your money comes from and just where it goes. Once that is determined, it is easy to put your finger on the strength or weakness of your system of farming. (Write to the Office of Farm Management, U. S. Department of Agriculture, for information regarding farm accounting, or send for Farmers' Bulletin 511.)

The kitchen garden.—Dr. T. N. Carver, of Harvard, has said that the worst thing about the average farmer's business system is that he "sells everything wholesale and buys everything retail." As long as the average farmer "keeps his garden on the grocery shelf," and eats peas and string beans out of tin cans, this criticism of his business method will hold good.

Many farmers nowadays seem to feel that it is beneath their dignity to bother with a garden. They wouldn't feel that way if they could

realize that side issues like a garden, a few chickens, milch cows, pigs, a few ewes, and a few colonies of bees—things that turn waste material and odds and ends of time into money—often make up the difference between loss and profit in the operation of a farm.

A well-kept half-acre garden will pay twice as much as any other half acre on the place. If you haven't such a garden it's time you fenced off the richest and best-drained half acre on the place and went into kitchen gardening as a serious undertaking, for you are violating one of the first principles of independent farming as long as you don't supply your own table with all the staple vegetables you need. (For fuller details about farm gardens, see Farmers' Bulletins 154 and 255.)

A smokehouse (which may be merely a barrel or a big store box set over a crude trench furnace) is another side issue that can be run with profit on any farm where hogs are raised. "Smoked ham" that really hasn't been smoked at all retails for something like 20 cents per pound, and bacon costs even more. The difference between the prices of ham, bacon, lard, etc., and the price of hogs on the hoof gives an idea of what you stand to gain by butchering your own hogs and smoking the hams and bacon at home. There is generally a good sale for any extra home-cured meats or rendered lard of high quality that the farmer may have to sell. (See Farmers' Bulletin 183 on home-cured meats.)

A small flock of chickens can be kept on the average farm with almost no outlay, since a reasonable number of chickens will thrive on what would otherwise be wasted. The return from such a flock, in the way of meat and eggs, is almost clear "velvet." (See Farmers' Bulletins 287 and 528 on poultry.)

There are still other side lines that may be mentioned in this connection, such as drying sweet corn, putting up sauerkraut, canning tomatoes and small fruits, making apple butter and other fruit butters, and storing or burying potatoes, beets, carrots, and other root crops for winter use—all practices that seem to be falling into disuse now, but all profitable to the farmer who is wise enough to include them in his farming scheme, and to see that the women of his household get all necessary help with this work. (For fuller details about canning vegetables, see Farmers' Bulletins 203 and 521.)

The farm home.—If the boys and girls are to be kept on the farm—the farm must be made not only a financial and economic success, but also a family and civic success. A truly successful farm must be vastly more than a workshop. It must be not only a place on which to make a living, but also a place to live on, a vital part of a rural community, of the State, and of the Nation. Moreover, financial success is important chiefly as a foundation for a home and a civic superstructure. After all, only that wealth which can be

translated into terms of life is really possessed by its owner. There are farmers with big farms, big herds, and big bank accounts, who seem to have no knack at utilizing their financial success for family happiness and welfare. It is not always the wealthiest farmer who has the most attractive front yard, orchard, and garden, or the coziest and most comfortable house. Some men's wealth is like a good deal of the fertility in their soil—it is "not available."

It does not necessarily cost much to make a farm homestead trim and green and the house sanitary and attractive. Most European farmers and many Eastern farmers, though their incomes average less than those of our farmers of the Middle West, take more pains to beautify their home surroundings than we do in the corn belt. No investment of time or money pays as large a return, dollar for dollar, as does the comparatively small amount spent on transforming the average farm house and yard into an attractive country home.

Moreover, when a farmer makes his home attractive and adds a garden that will supply the family needs, he has taken a long step toward making the farm a commercial and economic success. A farm house and garden may be considered as constituting the hub of the wheel to which the other factors of the farm are the spokes. You can't have much of a wheel without a sound and satisfactory hub. Any reasonable expenditure for making the home place more attractive is as real and profitable an investment as though the money had been spent for limestone or phosphate.

HORSE SENSE.

Legumes, lime, live stock, saving of waste, business methods, horse sense—these are the essentials for the highest success in corn-belt farming, and the greatest of these is horse sense, for in a way, it includes all the others.

Without horse sense there's a poor show for making a real money success of farming of any kind. Without that faculty, otherwise called "business ability," industry, capital, credit, and even a thorough knowledge of the most approved scientific methods of agriculture all will be of little avail. To qualify as a business farmer, a man must have that peculiar sort of "gumption" which enables him to shape his work and change his plans according to changing weather, shifting markets, and up-and-down business conditions. He must be able to decide whether he can best dispose of his crop by feeding, or by selling on the market. In selling either live stock or grain, the farmer should know enough of the actual value of his product to know when the local buyers are offering him a fair price. To know the actual value of his product he must know the freight rates to market, what commissions, insurance, and other expenses

must be met, as well as probable shrinkage, etc.; but these are facts that any farmer can easily secure.

It is not enough to grow a good crop, or even to grow a good crop at low cost. To make the big crop a business success it must be disposed of as efficiently as it is grown—must be so graded and packed as to meet market standards and so marketed as to bring the farmer the highest current prices.

Moreover, the farmer who is too suspicious to get together with his neighbors in order to do cooperatively what no one can do alone is sure to pay dearly for his lack of confidence and his incapacity for teamwork. The social spirit and a capacity for cooperative effort are fundamental necessities of the new agriculture. The day of the Ishmaelite and the individualist is over. The future belongs to the men who are able to cooperate with their fellows in pursuit of their common interests.

The farmer who sells all his crops at the elevator is robbing his own soil, his own purse, and his own children—selling their birthright for a mess of pottage. The farmer who not only does this, but also burns all his cornstalks and straw, reminds one of the burglar who takes all the valuables he can carry off and sets fire to what is left.

According to figures gathered recently by the Department of Agriculture, American farmers burn each year $65,000,000 worth of straw. When we consider, in addition to the straw thus wasted, the vast quantity of cornstalks burned, worth, on an average, $3 per acre for manure, and estimated to total in value fully as much as the straw burned, we begin to get some idea of the fertility that goes up in smoke on American farms each year. In exceptional cases it may be found advisable to burn straw and cornstalks. For instance, in order to get rid of insect pests, or in case there is no live stock to consume the straw, nor enough moisture to rot it if it is turned under. But it is safe to say that every year in the United States $100,000,000 worth of straw and cornstalks are burned that could advantageously be used for feed or fertilizer.

A man who fails to make a success of farming because of his failure to apply recognized principles of successful agriculture, or because of his failure to conform to recognized business principles, has largely himself to blame. Success to-day can not be gained by slipshod or happy-go-lucky methods. Certain well-known methods produce certain highly desirable results. A man may get a good crop occasionally in spite of inefficient methods. But to get the best obtainable crops and the best obtainable prices for those crops year after year requires a working knowledge of the science of agriculture and of sound business practice.

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